

Claims

1. A method for detecting multidrug resistance or multidrug resistance potential in a test neoplastic cell, comprising:
 - a) measuring a level of cell surface-expressed vimentin protein in the test neoplastic cell of a given origin or cell type, and
 - b) comparing the level of cell surface-expressed vimentin protein in the test neoplastic cell to the level of cell surface-expressed vimentin in a nonresistant neoplastic cell of the same origin or cell type,wherein the test neoplastic cell is multidrug resistant or has multidrug resistance potential if the level of cell surface-expressed vimentin in the test neoplastic cell is greater than the level of cell surface-expressed vimentin in the nonresistant neoplastic cell of the same given origin or cell type.
2. The method of claim 1, wherein measuring the level of cell surface-expressed vimentin in the test neoplastic cell comprises isolating a cytoplasmic membrane fraction from the cell and measuring the level of vimentin in the cytoplasmic membrane fraction.
3. The method of claim 1, wherein measuring the level of cell surface-expressed vimentin in the test neoplastic cell comprises contacting said cell with an anti-vimentin antibody and measuring the level of antibody bound to cell surface vimentin.
4. The method of claim 3, wherein measuring the level of antibody bound to cell surface vimentin is by immunofluorescence emission.
5. The method of claim 3, wherein measuring the level of antibody bound to cell surface vimentin is by radiolabel.
6. The method of claim 1, wherein the test neoplastic cell is selected from the group consisting of a promyelocytic leukemia cell, a T lymphoblastoid cell, a breast epithelial cell, and an ovarian cell.

7. The method of claim 1, wherein the nonresistant neoplastic cell is from a drug-sensitive cell line selected from the group consisting of HL60, NB4, CEM, HSB2 Molt4, MCF-7, MDA, SKOV-3, and 2008.
- 5 8. The method of claim 1, wherein the test neoplastic cell is selected from the group consisting of a lymphoma cell, a melanoma cell, a sarcoma cell, a leukemia cell, a retinoblastoma cell, a hepatoma cell, a myeloma cell, a glioma cell, a mesothelioma cell, and a carcinoma cell.
- 10 9. The method of claim 1, wherein the test neoplastic cell is from a tissue selected from the group consisting of blood, bone marrow, spleen, lymph node, liver, thymus, kidney, brain, skin, gastrointestinal tract, eye, breast, prostate, and ovary.
10. A method for detecting a multidrug resistant cell in a patient comprising:
- 15 (a) administering to the patient, a vimentin binding agent operably linked to a detectable label; and
- (b) detecting the label operably linked to the vimentin binding agent, wherein the vimentin binding agent specifically binds to cell surface-expressed vimentin present on a multidrug resistant cell in the patient.
- 20 11. The method of claim 10, wherein the vimentin binding agent is an antibody or fragment thereof.
12. The method of claim 10, wherein the vimentin binding agent is selected from the group consisting of modified LDL, NLK1 protein, vimentin, desmin, glial fibrillary acidic protein, and peripherin, fimbrin, RhoA-binding kinase alpha, and protein phosphatase 2A.
- 25 13. The method of claim 10, wherein the vimentin binding agent is selected from the group consisting of natural ligands, synthetic small molecules, chemicals, nucleic acids, peptides, proteins, and antibodies.
- 30 14. The method of claim 10, wherein the detectable label is selected from the group consisting of fluorophores, chemical dyes, radioactive compounds, chemoluminescent compounds, magnetic compounds, paramagnetic compounds, promagnetic compounds,

enzymes that yield a colored product, enzymes that yield a chemoluminescent product, and enzymes that yield a magnetic product.

15. The method of claim 14, wherein the multidrug resistant cell is a neoplastic cell.

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16. The method of claim 15, wherein the neoplastic cell is selected from the group consisting of a breast cancer cell, an ovarian cancer cell, a myeloma cancer cell, a lymphoma cancer cell, a melanoma cancer cell, a sarcoma cancer cell, a leukemia cancer cell, a retinoblastoma cancer cell, a hepatoma cancer cell, a glioma cancer cell, a mesothelioma cancer cell, and a carcinoma cancer cell.

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17. The method of claim 15, wherein the neoplastic cell is selected from the group consisting of a promyelocytic leukemia cell, a T lymphoblastoid cell, a breast epithelial cell, and an ovarian cell.

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18. The method of claim 10, wherein the patient is a human.

19. The method of claim 18, wherein the patient is suffering from a disease or disorder caused by the presence of the multidrug resistant cell.

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20. A kit for diagnosing or detecting multidrug resistance in a test neoplastic cell comprising:

- a) a first probe for the detection of vimentin; and
- b) a second probe for the detection of a multidrug resistance marker selected from the group consisting of nucleophosmin and HSC70.

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21. A kit for diagnosing or detecting multidrug resistance in a test neoplastic cell comprising:

- a) a first probe for the detection of vimentin; and
- b) a second probe for the detection of a marker selected from the group consisting of MDR1, MDR3, MRP1, MRP5, and LRP.

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22. The kit of claim 20 or 21, wherein the probe for detecting vimentin is an anti-vimentin antibody.

23. The kit of claim 20 or 21, wherein the probe for detecting vimentin is a vimentin ligand selected from the group consisting of LDL, NLK1 protein, vimentin, desmin, glial fibrillary acidic protein, and peripherin, fimbrin, RhoA-binding kinase alpha, and protein phosphatase 2A.
24. The kit of claim 20, wherein the second probe is selected from the group consisting of a nucleophosmin antibody and an HSC70 antibody.
25. The kit of claim 20, wherein the second probe is selected from the group consisting of a nucleophosmin ligand and an HSC70 ligand.
26. The kit of claim 20 or 21, wherein the first probe detects vimentin present on the surface of the test neoplastic cell.
27. The kit of claim 20 or 21, wherein the second probe detects a marker present of the surface of the test neoplastic cell.
28. The kit of claim 21, wherein the second probe is selected from the group consisting of: an MDR1 antibody, an MDR3 antibody, an MRP1 antibody, an MRP3 antibody, and an LRP antibody.
29. A cell surface vimentin *in situ* detection probe for the detection of cell surface vimentin in a patient, comprising a vimentin binding component and a detectable label for detection *in situ*.
30. The cell surface vimentin *in situ* detection probe of claim 29, wherein the vimentin binding component is an antibody.
31. The cell surface vimentin *in situ* detection probe of claim 29, wherein the detectable label is Technetium.
32. A cell surface vimentin-targeted agent for treating or preventing a multi-drug resistant neoplasm, comprising a vimentin binding component and a therapeutic component, wherein

the vimentin binding component targets the therapeutic component to the multi-drug resistant neoplasm and thereby treats the multi-drug resistant neoplasm.

33. The agent of claim 32, wherein the vimentin binding component is an anti-vimentin
5 antibody.

34. The agent of claim 32, wherein the vimentin binding component is selected from the group consisting of LDL, NLK1 protein, vimentin, desmin, glial fibrillary acidic protein, peripherin, fimbrin, RhoA-binding kinase alpha, and protein phosphatase 2A.

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35. The agent of claim 32, wherein said vimentin binding component is selected from the group consisting of natural ligands, synthetic small molecules, chemicals, nucleic acids, peptides, proteins, antibodies, and vimentin binding fragments thereof.

15 36. The agent of claim 32, wherein the therapeutic component is selected from the group consisting of Actinomycin, Adriamycin, Altretamine, Asparaginase, Bleomycin, Busulfan, Capecitabine, Carboplatin, Carmustine, Chlorambucil, Cisplatin, Cladribine, Cyclophosphamide, Cytarabine, Dacarbazine, Dactinomycin, Daunorubicin, Docetaxel, Doxorubicin, Epoetin, Etoposide, Fludarabine, Fluorouracil, Gemcitabine, Hydroxyurea,
20 Idarubicin, Ifosfamide, Imatinib, Irinotecan, Lomustine, Mechlorethamine, Melphalan, Mercaptopurine, Methotrexate, Mitomycin, Mitotane, Mitoxantrone, Paclitaxel, Pentostatin, Procarbazine, Taxol, Teniposide, Topotecan, Vinblastine, Vincristine, and Vinorelbine.

25 37. The agent of claim 32, wherein the therapeutic component is in a liposome formulation.

38. The agent of claim 32, wherein the therapeutic component is a radioisotope.

30 39. The agent of claim 38, wherein the radioisotope is selected from the group consisting of ⁹⁰Y, ¹²⁵I, ¹³¹I, ²¹¹At, and ²¹³Bi.

40. The agent of claim 32, wherein the therapeutic component is a toxin capable of killing or inducing the killing of the targeted multi-drug resistant neoplastic cell.

41. The agent of claim 40, wherein the toxin is selected from the group consisting of a *Pseudomonas* exotoxin, a diphtheria toxin, a plant ricin toxin, a plant abrin toxin, a plant saporin toxin, a plant gelonin toxin, and pokeweed antiviral protein.

5 42. The agent of any of claims 32-41, wherein the vimentin binding component binds to the surface of the target cell and the therapeutic element is internalized and arrests growth of the cell, compromises viability of the cell or kills the cell.

10 43. A vaccine for treating or preventing a multi-drug resistant neoplasm, comprising a vimentin polypeptide, or vimentin polypeptide subsequence thereof, and at least one pharmaceutically acceptable vaccine component.

15 44. The vaccine of claim 43, wherein the vimentin polypeptide or polypeptide subsequence is a human vimentin polypeptide sequence of SEQ ID NO.: 1.

45. The vaccine of claim 43, wherein the vimentin polypeptide subsequence is at least eight amino acids long.

20 46. The vaccine of claim 45, wherein the vimentin polypeptide subsequence comprises a hapten.

47. The vaccine of claim 43, wherein the pharmaceutically acceptable vaccine component is an adjuvant.

25 48. The vaccine of claim 47, wherein the adjuvant is selected from the group consisting of aluminum hydroxide, aluminum phosphate, calcium phosphate, oil emulsion, a bacterial product, whole inactivated bacteria, an endotoxins, cholesterol, a fatty acid, an aliphatic amine, a paraffinic compound, a vegetable oil, monophosphoryl lipid A, a saponin, and squalene.

30 49. A method of treating or preventing a multidrug resistant neoplasm in a subject comprising administering a cell surface vimentin-targeted therapeutic agent of any of claims 32-41.

50. The method of claim 49, wherein the neoplasm is selected from the group consisting of a breast cancer, an ovarian cancer, a myeloma, a lymphoma, a melanoma, a sarcoma, a leukemia, a retinoblastoma, a hepatoma, a glioma, a mesothelioma, and a carcinoma.

5 51. The method of claim 49, wherein the subject is a human patient.

52. The method of claim 51, wherein the human patient is suffering from a disease or disorder caused by the presence of the multi-drug resistant cell.

10 53. The method of claim 49, wherein the neoplasm is from a tissue selected from the group consisting of blood, bone marrow, spleen, lymph node, liver, thymus, kidney, brain, skin, gastrointestinal tract, eye, breast, prostate, and ovary.

54. A method of treating or preventing a multidrug resistant neoplasm in a subject
15 comprising administering a vimentin vaccine of any of claims 43-48.

55. The method of claim 54, wherein the neoplasm is selected from the group consisting of a breast cancer, an ovarian cancer, a myeloma, a lymphoma, a melanoma, a sarcoma, a leukemia, a retinoblastoma, a hepatoma, a glioma, a mesothelioma, and a carcinoma.

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56. The method of claim 54, wherein the subject is a human patient.

57. The method of claim 56, wherein the human patient is suffering from a disease or disorder caused by the presence of the multi-drug resistant cell.

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58. The method of claim 54, wherein the neoplasm is from a tissue selected from the group consisting of blood, bone marrow, spleen, lymph node, liver, thymus, kidney, brain, skin, gastrointestinal tract, eye, breast, prostate, and ovary.

30 59. A method for detecting whether a test cell is neoplastic comprising
a) measuring a level of cell surface-expressed vimentin protein in the test cell of a given origin or cell type, and

b) comparing the level of cell surface-expressed vimentin protein in the test cell to the level of cell surface-expressed vimentin in a nonneoplastic cell of the same origin or cell type,

5 wherein the test cell is neoplastic if the level of cell surface-expressed vimentin in the test cell is greater than the level of cell surface-expressed vimentin in the nonneoplastic cell of the same origin or cell type.

60. The method of claim 59, wherein measuring the level of cell surface-expressed vimentin in the test cell comprises isolating a cytoplasmic membrane fraction from the cell
10 and measuring the level of vimentin in the cytoplasmic membrane fraction.

61. The method of claim 59, wherein measuring the level of cell surface-expressed vimentin in the test cell comprises contacting said cell with an anti-vimentin antibody and measuring the level of antibody bound to cell surface vimentin.
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62. The method of claim 61, wherein measuring the level of antibody bound to cell surface vimentin is by immunofluorescence emission.

63. The method of claim 61, wherein measuring the level of antibody bound to cell
20 surface vimentin is by radiolabel.

64. The method of claim 59, wherein the test cell is from a tissue selected from the group consisting of blood, bone marrow, spleen, lymph node, liver, thymus, kidney, brain, skin, gastrointestinal tract, eye, breast, prostate, and ovary.
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65. The method of claim 59, wherein the nonneoplastic cell is from a tissue selected from the group consisting of blood, bone marrow, spleen, lymph node, liver, thymus, kidney, brain, skin, gastrointestinal tract, eye, breast, prostate, and ovary.

30 66. A method for detecting a neoplastic cell in a patient comprising:
(a) administering to the patient, a vimentin binding agent operably linked to a detectable label; and
(b) detecting the label operably linked to the vimentin binding agent,

wherein the vimentin binding agent specifically binds to cell surface-expressed vimentin present on a neoplastic cell in the patient.

67. The method of claim 66, wherein the vimentin binding agent is an antibody or
5 fragment thereof.

68. The method of claim 66, wherein the vimentin binding agent is selected from the group consisting of modified LDL, NLK1 protein, vimentin, desmin, glial fibrillary acidic protein, and peripherin, fimbrin, RhoA-binding kinase alpha, and protein phosphatase 2A.
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69. The method of claim 66, wherein the vimentin binding agent is selected from the group consisting of natural ligands, synthetic small molecules, chemicals, nucleic acids, peptides, proteins, antibodies, and fragments thereof.

70. The method of claim 66, wherein the detectable label is selected from the group consisting of fluorophores, chemical dyes, radioactive compounds, chemoluminescent compounds, magnetic compounds, paramagnetic compounds, promagnetic compounds, enzymes that yield a colored product, enzymes that yield a chemoluminescent product, and enzymes that yield a magnetic product.
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71. The method of claim 66, wherein the neoplastic cell is selected from the group consisting of a breast cancer cell, an ovarian cancer cell, a myeloma cancer cell, a lymphoma cancer cell, a melanoma cancer cell, a sarcoma cancer cell, a leukemia cancer cell, a retinoblastoma cancer cell, a hepatoma cancer cell, a glioma cancer cell, a mesothelioma cancer cell, and a carcinoma cancer cell.
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72. The method of claim 66, wherein the neoplastic cell is selected from the group consisting of a promyelocytic leukemia cell, a T lymphoblastoid cell, a breast epithelial cell, and an ovarian cell.
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73. The method of claim 66, wherein the patient is a human.

74. The method of claim 73, wherein the patient is suffering from a disease or disorder caused by the presence of the neoplastic cell.

75. A kit for diagnosing or detecting neoplasia, comprising:
a) a first probe for the detection of vimentin; and
b) a second probe for the detection of a neoplasia marker selected from the group
5 consisting of nucleophosmin and HSC70.
76. The kit of claim 75, wherein the probe for detecting vimentin is an anti-vimentin antibody or binding fragment thereof.
- 10 77. The kit of claim 75, wherein the probe for detecting vimentin is a vimentin ligand selected from the group consisting of LDL, NLK1 protein, vimentin, desmin, glial fibrillary acidic protein, and peripherin, fimbrin, RhoA-binding kinase alpha, and protein phosphatase 2A.
- 15 78. The kit of claim 75, wherein the second probe is selected from the group consisting of a nucleophosmin antibody and an HSC70 antibody.
79. The kit of claim 75, wherein the second probe is selected from the group consisting of a nucleophosmin ligand and an HSC70 ligand.
- 20 80. The kit of claim 75, wherein the first probe detects vimentin present on the surface of the test cell if it is neoplastic.
81. The kit of claim 75, wherein the second probe detects a marker present of the surface
25 of the test cell if it is neoplastic.
82. A cell surface vimentin-targeted agent for treating a cancerous neoplastic cell growth comprising a vimentin binding component and a therapeutic component, wherein the vimentin binding component targets the therapeutic component to the neoplastic cell growth
30 and thereby treats the cancer.
83. The agent of claim 82, wherein the vimentin binding component is an anti-vimentin antibody.

84. The agent of claim 82, wherein the vimentin binding component is selected from the group consisting of LDL, NLK1 protein, vimentin, desmin, glial fibrillary acidic protein, and peripherin, fimbrin, RhoA-binding kinase alpha, and protein phosphatase 2A.
- 5 85. The agent of claim 82, wherein said vimentin binding component is selected from the group consisting of natural ligands, synthetic small molecules, chemicals, nucleic acids, peptides, proteins, antibodies, and vimentin binding fragments thereof.
- 10 86. The agent of claim 82, wherein the therapeutic component is selected from the group consisting of Actinomycin, Adriamycin, Altretamine, Asparaginase, Bleomycin, Busulfan, Capecitabine, Carboplatin, Carmustine, Chlorambucil, Cisplatin, Cladribine, Cyclophosphamide, Cytarabine, Dacarbazine, Dactinomycin, Daunorubicin, Docetaxel, Doxorubicin, Epoetin, Etoposide, Fludarabine, Fluorouracil, Gemcitabine, Hydroxyurea, Idarubicin, Ifosfamide, Imatinib, Irinotecan, Lomustine, Mechlorethamine, Melphalan, 15 Mercaptopurine, Methotrexate, Mitomycin, Mitotane, Mitoxantrone, Paclitaxel, Pentostatin, Procarbazine, Taxol, Teniposide, Topotecan, Vinblastine, Vincristine, and Vinorelbine and combinations thereof.
- 20 87. The agent of claim 82, wherein the therapeutic component is in a liposome formulation.
88. The agent of claim 82, wherein the therapeutic component is a radioisotope.
- 25 89. The agent of claim 88, wherein the radioisotope is selected from the group consisting of ⁹⁰Y, ¹¹¹In, ¹²⁵I, ¹³¹I, ²¹¹At, and ²¹³Bi.
90. The agent of claim 82, wherein the therapeutic component is a toxin capable of killing or inducing the killing of the targeted neoplastic cell.
- 30 91. The agent of claim 90, wherein the toxin is selected from the group consisting of a Pseudomonas exotoxin, a diphtheria toxin, a plant ricin toxin, a plant abrin toxin, a plant saporin toxin, a plant gelonin toxin, and pokeweed antiviral protein.

92. The agent of any of claims 82-91, wherein the vimentin binding component binds to the surface of the target cell and the therapeutic element is internalized and arrests growth of the cell, compromises viability of the cell, or kills the cell.

5 93. A vaccine for treating or preventing a neoplasm comprising a vimentin polypeptide, or vimentin polypeptide subsequence thereof, and at least one pharmaceutically acceptable vaccine component.

94. The vaccine of claim 93, wherein the vimentin polypeptide or polypeptide
10 subsequence is a human vimentin polypeptide sequence set forth in SEQ ID NO.: 1.

95. The vaccine of claim 93, wherein the vimentin polypeptide subsequence is at least eight amino acids long.

15 96. The vaccine of claim 95, wherein the vimentin polypeptide subsequence comprises a hapten.

97. The vaccine of claim 93, wherein the pharmaceutically acceptable vaccine component is an adjuvant.

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98. The vaccine of claim 97, wherein the adjuvant is selected from the group consisting of aluminum hydroxide, aluminum phosphate, calcium phosphate, oil emulsion, a bacterial product, whole inactivated bacteria, an endotoxins, cholesterol, a fatty acid, an aliphatic amine, a paraffinic compound, a vegetable oil, monophosphoryl lipid A, a saponin, and
25 squalene.

99. A method of treating or preventing a neoplasm in a subject comprising administering a cell surface vimentin-targeted therapeutic agent of any of claims 82-91.

30 100. The method of claim 99, wherein the neoplasm is selected from the group consisting of a breast cancer, an ovarian cancer, a myeloma, a lymphoma, a melanoma, a sarcoma, a leukemia, a retinoblastoma, a hepatoma, a glioma, a mesothelioma, and a carcinoma.

101. The method of claim 99, wherein the subject is a human patient.

102. The method of claim 101, wherein said human patient is suffering from a disease or disorder caused by the presence of the multi-drug resistant cell.

5 103. The method of claim 99, wherein the neoplasm is from a tissue selected from the group consisting of blood, bone marrow, spleen, lymph node, liver, thymus, kidney, brain, skin, gastrointestinal tract, eye, breast, prostate and ovary.

104. A method of treating or preventing a neoplasm in a subject comprising administering
10 a vimentin vaccine of any of claims 93-98.

105. The method of claim 104, wherein the neoplasm is selected from the group consisting of a breast cancer, an ovarian cancer, a myeloma, a lymphoma, a melanoma, a sarcoma, a leukemia, a retinoblastoma, a hepatoma, a glioma, a mesothelioma, and a carcinoma.

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106. The method of claim 104, wherein said subject is a human patient.

107. The method of claim 106, wherein said human patient is suffering from a disease or disorder caused by the presence of the neoplastic cell.

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108. The method of claim 104, wherein the neoplasm is from a tissue selected from the group consisting of blood, bone marrow, spleen, lymph node, liver, thymus, kidney, brain, skin, gastrointestinal tract, eye, breast, prostate, and ovary.